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(71)(72) Applicant and Inventor: HENCK, Ronald, W. [US/US]; S16 W32069 Highmeadows, Delafield, WI 53018 (US).

(74) Agent: BARRY, Ronald, E.; Frisch, Dudek and Slattery, Ltd., 825 North Jefferson Street, Milwaukee, WI 53202 (US).

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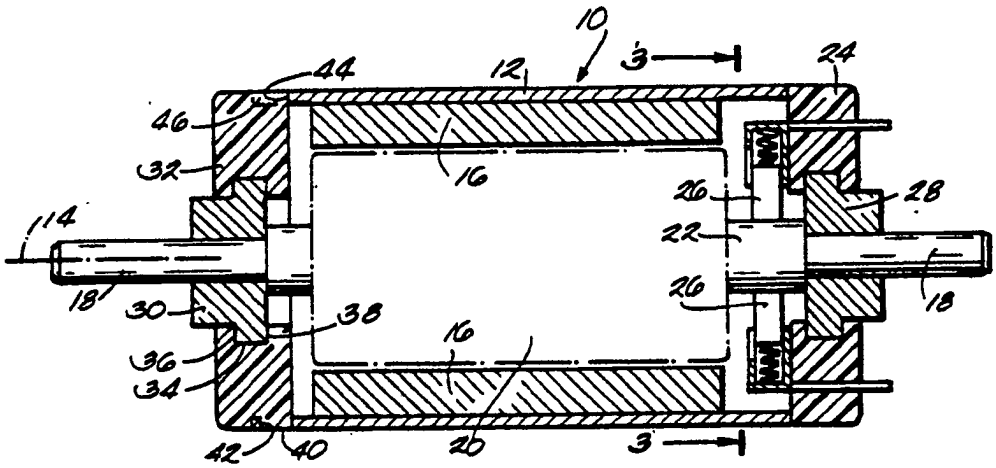

(57) Abstract

An electric motor comprising a generally cylindrical housing (12) including an end and a longitudinal axis (14) a rotor assembly located inside the housing and including a shaft (18) extending along the longitudinal axis and an armature assembly (20) mounted on the shaft, a bearing (30) rotatably supporting the shaft, and a unitary, plastic end bell (32) closing the end of the housing and being molded around the bearing.

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ELECTRIC MOTOR AND METHOD FOR MANUFACTURING THE SAME

Background of the Invention

The invention relates to electric motors and to methods for manufaturing electric motors. More particularly, the invention relates to end bells or caps for electric motors and to methods for forming the end bell or cap of an electric motor.

U.S. MacMillan Patent No. 4,357,552 discloses an end bell "molded about" a portion of the motor casing. The outer surface of the end bell has therein a cylindrical recess or pocket which receives and supports a bearing which in turn supports the output shaft of the motor.

U.S. Hult Patent No. 3,760,209 discloses a motor including a two-piece end bell which "captures" and supports a bearing for the output shaft.

Attention is also directed to the following U.S. patents which disclose electric motors:

Frey	4,088,910	May 9, 1978
Lindgren	3,161,794	Dec. 15, 1964
Singh et al.	4,031,610	June 28, 1977
de Jong	4,414,481	Nov. 8, 1983
Kaufman, Jr.	4,048,530	Sept. 13, 1977
Hahndorf et al.	3,391,290	July 2, 1968
Spitler et al.	4,384,224	May 17, 1983
Shiseki et al.	4,438,358	Mar. 20, 1984

Summary of the Invention

The invention provides an electric motor comprising a generally cylindrical housing including

an end, and a rotor assembly located inside the housing and including a shaft extending outwardly through the end of the housing. The rotor assembly also includes an armature assembly mounted on the shaft.

The motor further comprises a bearing for rotatably supporting the shaft, and a unitary (i.e., one-piece), plastic end bell which is molded around the bearing and which is molded in place on the end of the housing to close the end of the housing. Preferably, the bearing includes an annular flange extending outwardly and generally perpendicularly to the shaft, the flange having opposite inner and outer surfaces spaced in the direction of the axis of the shaft, and the bearing is captured by or molded within the end bell so that the end bell contacts both of the inner and outer surfaces of the bearing flange to hold the bearing in place relative to the housing.

In the preferred embodiment, the housing has therein a plurality of apertures spaced from the end of the housing. When the end bell is molded in place relative to the housing, the end bell forms a plurality of projections respectively received in the apertures for securing the end bell to the housing.

The invention also provides a method for manufacturing the above-described motor. The method comprises the steps of providing the housing and the

bearing, and providing a mold form defining a molding chamber for the end bell. In the preferred embodiment, the mold form includes an annular recess which receives the housing, and the mold form forms the molding chamber around the end of the housing. More particularly, the mold form includes a base which receives the housing and which defines the bottom of the molding chamber, and a top which is mounted on the base over the end of the housing and which defines the sides and top of the molding chamber. The base includes an upwardly extending projection which supports the bearing within the molding chamber, and the top includes a generally cylindrical recess which receives the upper or outer end of the bearing for positioning the bearing relative to the end of the housing.

The method further comprises the steps of locating the housing in the mold form with the end of the housing in the molding chamber, and placing the bearing inside the molding chamber on the projection. As mentioned above, the recess in the top of the mold form holds the bearing in proper position.

The method further comprises the step of delivering molten plastic into the mold chamber. The plastic surrounds the bearing and becomes molded to the housing so that, when the plastic hardens, the plastic forms the end bell.

A principal feature of the invention is the provision of a unitary or one-piece end bell molded around a bearing. This construction is simpler than known constructions and provides more effective support of the bearing.

Another principal feature of the invention is the method for making the motor. The method is simple and yet provides the above-described improved end bell.

Other principal features and advantages of the invention will become apparent to those skilled in the art upon review of the following detailed description, claims and drawings.

Description of the Drawings

Fig. 1 is a perspective view of an electric motor embodying the invention.

Fig. 2 is a cross-sectional view of the motor.

Fig. 3 is a cross-sectional view taken along line 3-3 in Fig. 2.

Fig. 4 is an end view (the left end in Figs. 1 and 2) of the motor.

Fig. 5 is a vertical cross-sectional view of a mold form used in performing the method of the invention.

Fig. 6 is a top view of the base of the mold form.

Fig. 7 is a partial view of the upper portion of the mold form shown in Fig. 5 with molten plastic filling the molding chamber.

Before one embodiment of the invention is explained in detail, it is to be understood that the invention is not limited in its application to the details of construction and the arrangements of components set forth in the following description or illustrated in the drawings. The invention is capable of other embodiments and of being practiced or being carried out in various ways. Also, it is to be understood that the phraseology and terminology used herein is for the purpose of description and should not be regarded as limiting.

Description of the Preferred Embodiment

An electric motor 10 embodying the invention is shown in the drawings. As best shown in Fig. 2, the motor 10 comprises a generally cylindrical housing 12 including opposite right and left ends and a longitudinal axis 14. The motor 10 also comprises a pair of stator elements 16 mounted inside the housing 12, and a rotor assembly located inside the housing 12 and inside the stator elements 16. The rotor assembly includes a shaft 18 extending along the longitudinal axis 14 of the housing 12, an armature assembly 20 mounted on the shaft 18, and a commutator 22 connected to the armature assembly 20.

The motor 10 also comprises a pair of brushes 26 which contact the commutator 22 and which are adapted to be connected to a power source.

The motor 10 further comprises a bearing 28 rotatably supporting the right end of the shaft 18, and a bearing 30 rotatably supporting the left end of the shaft 18.

The motor 10 further comprises a unitary (i.e., one-piece), plastic end bell 32 closing the left end of the housing 12 and being molded around the bearing 30. The bearing 30 and the end bell 32 include interengaging means for preventing movement of the bearing 30 relative to the end bell 32 in both directions along the longitudinal axis 14 of the housing. While various suitable interengaging means can be employed, in the illustrated construction, the bearing 30 includes an annular flange 34 extending radially outwardly and generally perpendicularly to the longitudinal axis 14. The flange 34 has opposite outer and inner or left and right surfaces 36 and 38, respectively, spaced in the direction of the longitudinal axis 14, and the end bell 32 is molded around the bearing 30 so as to contact both of the left and right surfaces 36 and 38, thereby preventing movement of the bearing 30 in the direction of the longitudinal axis 14. The end bell 32 also contacts the radially outer surfaces of the bearing 30 to

prevent movement of the bearing 30 radially of the longitudinal axis 14.

The motor 10 further comprises interengaging means on the housing 12 and on the end bell 32 for securing the end bell 32 to the housing 12. While various suitable interengaging means can be used, in the preferred embodiment, the interengaging means includes, in the housing 12, a plurality of recesses 42 adjacent the end of the housing, and, on the end bell 32, a plurality of integral projections 40 respectively received in the recesses 42. In the illustrated construction, the housing 12 includes a plurality of apertures spaced from the end of the housing 12 and defining the recesses 42. Furthermore, in the preferred embodiment, the interengaging means includes, in the left end of the housing 12, a plurality of longitudinally extending recesses 44, and, on the end bell 32, a plurality of integral projections 46 respectively received in the longitudinally extending recesses 44. Both the apertures 42 and the longitudinally extending recesses 44 prevent rotation of the end bell 32 relative to the housing 12, and the apertures 42 further prevent movement of the end bell relative to the housing in the direction of the longitudinal axis 14.

As shown in Fig. 4, the end bell 32 has therein a pair of generally cylindrical openings 48

for facilitating mounting of the motor 10, and a pair of arcuate vent openings 50.

The motor 10 further comprises (See Figs. 2 and 3) an end bell 24 closing the right end of the housing 12 and supporting the brushes 26 and the bearing 28. While the end bell 24 can be of conventional construction, in the illustrated construction, the end bell 24 at least partially embodies the invention in that it is unitary and captures the bearing 28. The end bell 24 can be secured to the right end of the housing 12 by any suitable means.

A mold form 52 for performing the method of the invention, i.e., a method for manufacturing the motor 10, is illustrated in Figs. 5 through 7.

As best shown in Fig. 5, the mold 52 form includes a base 54 which defines an annular recess 56 for receiving the housing 12. The right end of the housing 12 is inserted into the recess 56 in the base 54, and the left end of the housing 12 extends upwardly out of the base 54. The base 54 has an upper surface 58 which defines the bottom of a molding chamber 60 for forming the end bell 32. The base 54 includes a pair of generally cylindrical, upwardly extending projections 62 which form the openings 48 in the end bell 32, and a pair of arcuate, upwardly extending projections 64 which form the arcuate openings 50 in the end bell. The base 54

also includes a generally cylindrical, upwardly extending projection 66 for supporting the bearing 30 within the molding chamber 60.

The mold form 52 also includes a top 68 which is mounted on the base 54 and which defines the sides and top of the molding chamber 60. Thus, the top 68 and the base 54 cooperate to define the molding chamber 60. The top 68 contacts the projections 62 and the arcuate projections 64, and the top 68 fits over the end of the housing 12 and is thereby held in position relative to the housing 12. The top 68 can be secured to the base 54 by any suitable means.

The top 68 includes a gate 70 communicating with the molding chamber 60, and a vent 72 communicating with the molding chamber 60. Preferably, the top 68 also includes means for positioning the bearing 30 relative to the end of the housing 12. While various suitable positioning means can be used, in the illustrated construction, the positioning means includes a generally cylindrical recess 74 in the top 68 of the mold form 52. The recess 74 receives the top or outer portion of the bearing 30 and thereby positions the bearing within the molding chamber 60 and relative to the end of the housing 12.

The method of the invention is performed as follows: The housing 12 is inserted into the annular

recess 56 in the base 54, as shown in Fig. 5, and the bearing 30 is placed on the projection 66. The top 68 is then placed over the end of the housing 12 and on the base 54 with the outer portion of the bearing 30 received in the recess 74. When the top 68 is placed on the base 54, the top 68 and base 54 define the molding chamber 60, the end of the housing 12 is located within the molding chamber 60, and the bearing 30 is located within the molding chamber 60 in proper position relative to the end of the housing 12. Finally, molten plastic 76 is delivered into the molding chamber 60 via the gate 70. As shown in Fig. 7, the molten plastic 76 surrounds the bearing 30 and fills the apertures 42 and the longitudinally extending recesses 44. When the plastic hardens, it forms the end bell 32 closing the end of the housing 12 and surrounding or capturing the bearing 30.

In accordance with this invention an end bell closure is provided for the motor housing 12 which is molded in place and secured to the motor housing 12 through a molded interengagement between the end bell and the housing 12 without the need for any separate screws or the like or the need for additional assembly steps such as deforming the housing end to engage the end bell, while at the same time the bearing 30 is molded in place in the end bell. The location of the bearing axis is thereby accurately controlled for true mounting of the motor

armature. This has a positive effect on improving motor performance and extending motor life. For example, by maintaining a concentric relationship between the armature and the stator magnets 16, a stronger and more efficient magnetic field is produced. The preferred interengagement is shown as molded projections 40 in apertures or recesses 42. This holds the end bell assembled on the housing 12. The engagement between the projections 46 and recesses 44 resists any torque which may be applied to the end bell in operation, thereby allowing this concept to be used with larger size motors, if desired.

Various other features and advantages of the invention are set forth in the following claims.

CLAIMS

1. An electric motor comprising

a generally cylindrical housing including an end and a longitudinal axis,

a rotor assembly located inside said housing and including a shaft extending along said longitudinal axis and an armature assembly mounted on said shaft,

a bearing rotatably supporting said shaft,

a unitary, plastic end bell closing said end of said housing and being molded around said bearing, and

interengaging means on said housing and on said end bell for securing said end bell to said housing.

2. A motor as set forth in Claim 1 wherein said interengaging means includes, in said housing, a plurality of recesses adjacent said end of said housing, and, on said end bell and integral therewith, a plurality of projections respectively received in said recesses.

3. A motor as set forth in Claim 2 wherein said housing includes a plurality of apertures spaced from said end of said housing and defining said recesses.

4. A motor as set forth in Claim 2 wherein said interengaging means further includes, in said end of said housing, a plurality of longitudinally extending recesses, and, on said end bell and integral therewith, a plurality of projections respectively received in said longitudinally extending recesses.

5. A motor as set forth in Claim 1 wherein said bearing includes an annular flange extending radially outwardly and generally perpendicularly to said longitudinal axis, said flange having opposite inner and outer surfaces spaced in the direction of said longitudinal axis, and wherein said end bell is molded around said bearing so as to contact both of said inner and outer surfaces, thereby preventing movement of said bearing in the direction of said longitudinal axis.

6. A motor as set forth in Claim 1 wherein said bearing and said end bell include interengaging means for preventing movement of said bearing relative to said end bell in both directions along said longitudinal axis.

7. An electric motor comprising

a generally cylindrical housing including an end, a longitudinal axis, and a plurality of apertures adjacent said end of said housing,

a rotor assembly located inside said housing and including a shaft extending along said longitudinal axis and an armature assembly mounted on said shaft,

a bearing rotatably supporting said shaft and including an annular flange extending radially outwardly and generally perpendicularly to said longitudinal axis, said flange having opposite inner and outer surfaces spaced in the direction of said longitudinal axis, and

a unitary, plastic end bell closing said end of said housing and being molded around said bearing so as to contact both of said inner and outer surfaces, thereby preventing movement of said bearing in the direction of said longitudinal axis, said end bell including a plurality of integral projections respectively received in said apertures.

8. In an electric motor including an armature, a housing enclosing said armature, and bearings rotatably supporting the opposite ends of said armature, the improvement comprising an end bell molded around one of said bearings and having an interengagement with said one of said bearings such that said bearing is held captive in said end bell.

9. The electric motor of claim 8 wherein said end bell is further characterized in that it includes integral projections molded in engagement with said housing adjacent the end of said housing to prevent axial and rotational movement of said end bell, and the bearing held captive thereby, relative to said armature.

10. A method for manufacturing an electric motor, said method comprising the steps of

providing a generally cylindrical housing including an end,

providing a bearing for rotatably supporting a shaft,

providing means defining a molding chamber,

locating said end of said housing within said molding chamber,

locating said bearing within said molding chamber in proper position relative to said end of said housing, and

delivering molten plastic into said chamber,

whereby said molten plastic surrounds said bearing and becomes molded to said housing so that, when said plastic hardens, said plastic forms an end bell closing said end of said housing and surrounding said bearing.

11. A method as set forth in Claim 10 wherein said means defining said chamber includes means for positioning said bearing relative to said end of said housing.

12. A method as set forth in Claim 10 wherein said housing includes a plurality of recesses spaced from said end, whereby said molten plastic fills said recesses to provide means for securing said end bell to said housing.

AMENDED CLAIMS
[received by the International Bureau on 12 October 1987 (12.10.87)
original claims 1-12 replaced by amended claims 1-12 (3 pages)]

1. An electric motor comprising

a generally cylindrical housing including an end and a longitudinal axis, interengaging means at said end of said housing,

a rotor assembly located inside said housing and including a shaft extending along said longitudinal axis and an armature assembly mounted on said shaft,

a bearing located at said end of said housing for rotatably supporting one end of said shaft, and

a unitary, plastic end bell closing said end of said housing and being molded around said bearing and extending into said

interengaging means on said end of said housing for positively locating said bearing in said end of said housing.

2. A motor as set forth in Claim 1 wherein said interengaging means includes, in said housing, a plurality of recesses adjacent said end of said housing, and, on said end bell and integral therewith, a plurality of projections respectively received in said recesses.

3. A motor as set forth in Claim 2 wherein said housing includes a plurality of aperatures spaced from said end of said housing and defining said recesses.

4. A motor as set forth in Claim 2 wherein said interengaging means further includes, in said end of said housing, a plurality of longitudinally extending recesses, and, on said end bell and integral therewith, a plurality of projections respectively received in said longitudinally extending recesses..

5. A motor as set forthin Claim 1 wherein said bearing includes an annular flange extending radially outwardly and generally perpendicularly to said longitudinal axis, said flange having opposite inner and outer surfaces spaced in the direction of said longitudinal axis, and wherein said end bell is molded around said bearing so as to contact both of said inner and outer surfaces, thereby preventing movement of said bearing in the direction of said longitudinal axis.

6. A motor as set forth in Claim 1 wherein said bearing and said end bell include interengaging means for preventing movement of said bearing relative to said end bell in both directions along said longitudinal axis.

7. An electric motor comprising

a generally cylindrical housing including an end, a longitudinal axis, and a plurality of apertures adjacent said end of said housing,

a rotor assembly located inside said housing and including a shaft extending along said longitudinal axis and an armature assembly mounted on said shaft,

a bearing rotatably supporting said shaft and incuding an annular flange extending radially outwardly and generally perpendicularly to said longitudinal axis, said flange having opposite inner and outer surfaces spaced in the direction of said longitudinal axis, and

a unitary, plastic end bell closing said end of said housing and being molded around said bearing so as to contact both of said inner and outer surfaces and including a plurality of integral projections received in said aperatures, thereby preventing movement of said bearing with respect to said end of said housing.

8. In an electric motor including an armature, a housing enclosing said armature and having a plurality of openings around one end of said housing, and bearings rotatably supporting the opposite ends of said armature, the improvement comprising an end bell molded around one of said bearings and having an interengagment with said one of said bearings and said openings in said one end of said housing, such that said bearing is fixed with respect to said one end of said housing and said end bell.

9. The electric motor of claim 8 wherein said end bell is further characterized in that it includes integral projections molded in engagement with said openings in said housing adjacent said end of said housing to prevent axial and rotational movement of said end bell, and the bearing held captive thereby, relative to said armature.

10. A method for manufacturing an electric motor, said method comprising the steps of

providing a generally cylindrical housing including an end,

providing a bearing for rotatably supporting a shaft,

providing means defining a molding chamber,

locating said end of said housing within said molding chamber,

locating said bearing within said molding chamber in proper position relative to said end of said housing, and

delivering molten plastic into said chamber,

whereby said molten plastic surrounds said bearing and becmes molded to said housing so that, when said plastic hardens, said plastic forms an end bell closing said end of said housing and surrounding said bearing.

11. A method as set forth in Claim 10 wherein said means defining said chamber includes means for positioning said bearing relative to said end of said housing.

12. A method as set forth in Claim 10 wherein said housing includes a plurality of recesses spaced from said end, whereby said molten plastic fills said recesses to provide means for securing said end bell to said housing.

AMENDED CLAIMS
[received by the International Bureau on 7 March 1988 (07.03.88);
original claims 1-12 replaced by amended claims 1-18 (5 pages)]

1. An electric motor comprising

a generally cylindrical housing including an end and a longitudinal axis, interengaging means at said end of said housing,

a rotor assembly located inside said housing and including a shaft extending along said longitudinal axis and an armature assembly mounted on said shaft,

a bearing located at said end of said housing for rotatably supporting one end of said shaft, and

a unitary, plastic end bell closing said end of said housing and being molded around said bearing and extending into said

interengaging means on said end of said housing for positively locating said bearing in said end of said housing.

2. A motor as set forth in Claim 1 wherein said interengaging means in said housing is characterized by a plurality of recesses adjacent said end of said housing, and, on said end bell and integral therewith, a plurality of projections respectively received in said recesses.

3. A motor as set forth in Claim 2 wherein said housing is characterized by a plurality of aperatures spaced from said end of said housing and defining said recesses.

4. A motor as set forth in Claim 2 wherein said interengaging means in said end of said housing is further characterized by a plurality of longitudinally extending recesses, and, on said end bell and integral therewith, a plurality of projections respectively received in said longitudinally extending recesses..

5. A motor as set forth in Claim 1 wherein said bearing is characterized by an annular flange extending radially outwardly and generally perpendicularly to said longitudinal axis, said flange having opposite inner and outer surfaces spaced in the direction of said longitudinal axis, and wherein said end bell is molded around said bearing so as to contact both of said inner and outer surfaces, thereby preventing movement of said bearing in the direction of said longitudinal axis.

6. A motor as set forth in Claim 1 wherein said bearing and said end bell are characterized by interengaging means for preventing movement of said bearing relative to said end bell in both directions along said longitudinal axis.

7. An electric motor wherein the improvement comprises

a generally cylindrical housing including an end, a longitudinal axis, and a plurality of apertures adjacent said end of said housing,

a rotor assembly located inside said housing and including a shaft extending along said longitudinal axis and an armature assembly mounted on said shaft,

a bearing rotatably supporting said shaft and including an annular flange extending radially outwardly and generally perpendicularly to said longitudinal axis, said flange having opposite inner and outer surfaces spaced in the direction of said longitudinal axis, and

a unitary, plastic end bell closing said end of said housing and being molded around said bearing so as to contact both of said inner and outer surfaces and including a plurality of integral projections received in said aperatures, thereby preventing movement of said bearing with respect to said end of said housing.

8. In an electric motor including an armature, a housing enclosing said armature and having a plurality of openings around one end of said housing, and bearings rotatably supporting the opposite ends of said armature, wherein the improvement comprises an end bell molded around one of said bearings and having an interengagement with said one of said bearings and said openings in said one end of said housing, such that said bearing is fixed with respect to said one end of said housing.

9. The electric motor of claim 8 wherein said end bell is further characterized in that it includes integral projections molded in engagement with said openings in said housing adjacent said end of said housing to prevent axial and rotational movement of said end bell, and the bearing held captive thereby, relative to said armature.

10. A method for manufacturing an electric motor, said method comprising the steps of

providing a generally cylindrical housing including an end,

providing a bearing for rotatably supporting a shaft

providing means defining a molding chamber,

locating said end of said housing within said molding chamber,

locating said bearing within said molding chamber in proper position relative to said end of said housing, and

delivering molten plastic into said chamber,

whereby said molten plastic surrounds said bearing and becomes molded to said housing so that, when said plastic hardens, said plastic forms an end bell closing said end of said housing and surrounding said bearing.

11. A method as set forth in Claim 10 wherein said means defining said chamber includes means for positioning said bearing relative to said end of said housing.

12. A method as set forth in Claim 10 wherein said housing includes a plurality of recesses spaced from said end, whereby said molten plastic fills said recesses to provide means for securing said end bell to said housing.

13. An electric motor having an end bell formed by the method of Claims 10, 11 or 12.

14. A method of forming an end bell on the housing for an electric motor, said method comprising the steps of

forming a plurality of recesses around one end of the cylindrical motor housing,

forming a shaft bearing with a radically extending flange around the periphery thereof,

providing a molding form including a top and a base,

forming a cylindrical opening corresponding to the cylindrical housing in the base,

positioning the cylindrical housing in the cylindrical opening in the base with said one end projecting outward from the base with the recesses exposed

positioning the shaft bearing on the base in axial alignment with the cylindrical housing,

forming a cylindrical molding chamber in said top having a diameter corresponding to the diameter of said housing and a recess corresponding to the shape of said shaft bearing,

placing the top on the base to enclose the exposed end of the cylinder and the shaft bearing,

and filling the molding chamber and the recesses in the end of the housing with molten plastic,

and allowing the molten plastic to harden whereby the shaft bearing will be positively located with respect to the cylindrical housing.

15. The method according to Claim 14 including the step of forming a recess in the top in axial alignment with the cylindrical molding chamber and conforming to the shape of said shaft bearing and

aligning the shaft bearing in said recess whereby the shaft bearing will be axially aligned with the cylindrical housing when the plastic hardens.

16. The method according to Claim 15 including the step of forming a platform on said base to support said shaft bearing, said platform being smaller than said flange on said shaft bearing whereby said plastic will surround said flange on said shaft bearing.

17. The method according to Claim 16 including the step of forming a pair of arcuate projections on said base to define vent openings in said end bell.

18. An electric motor having an end bell formed on one end of the housing with the shaft bearing molded into the end bell by the method of Claims 14, 15, 16 or 17.

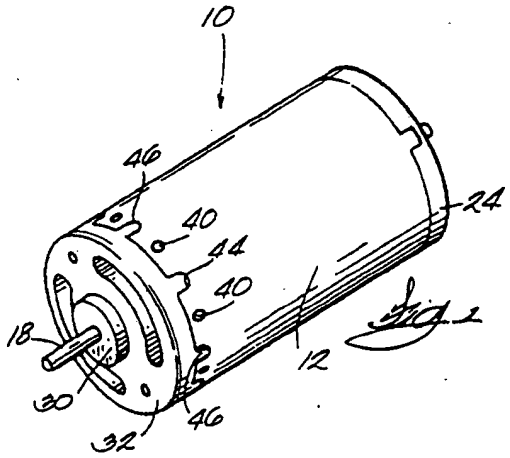


Fig. 1

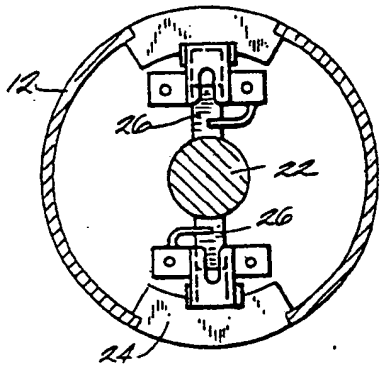
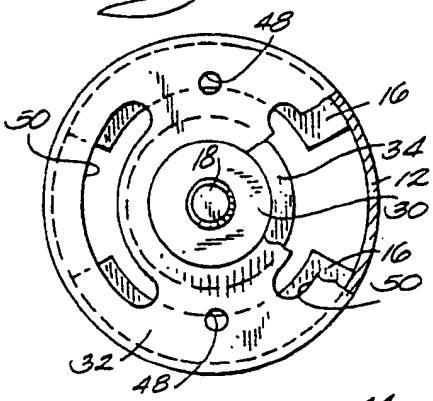


Fig. 3

Fig. 4



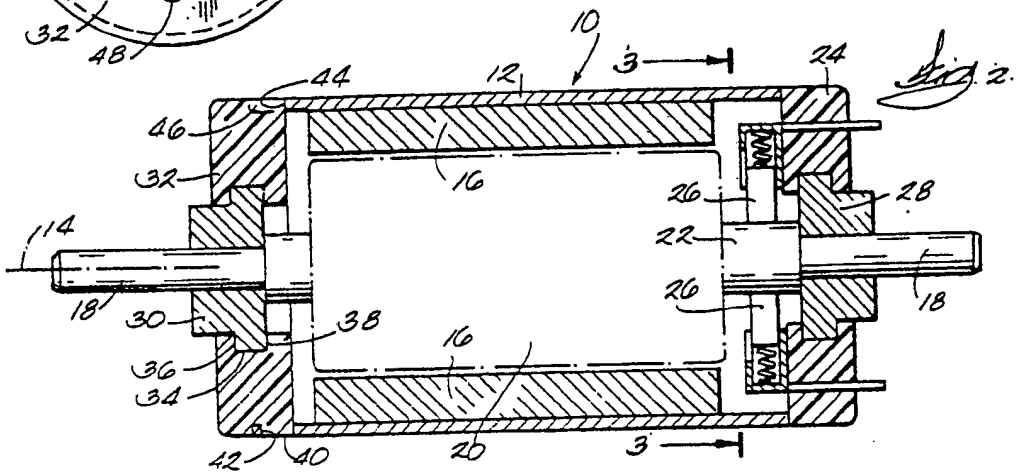


Fig. 2

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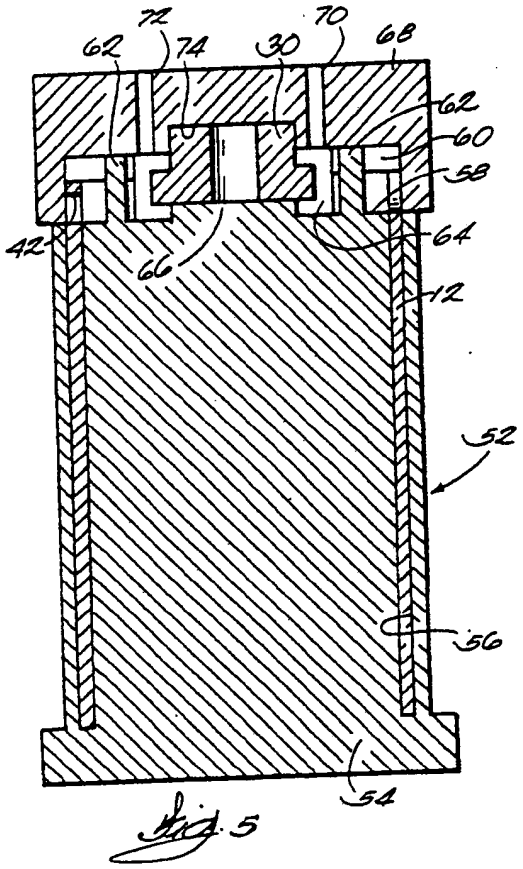

Fig. 5

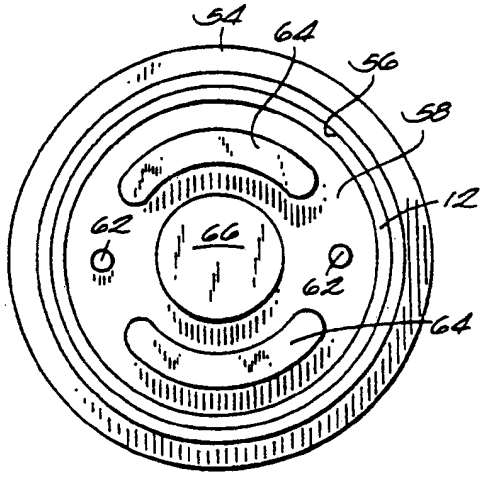

Fig. 6

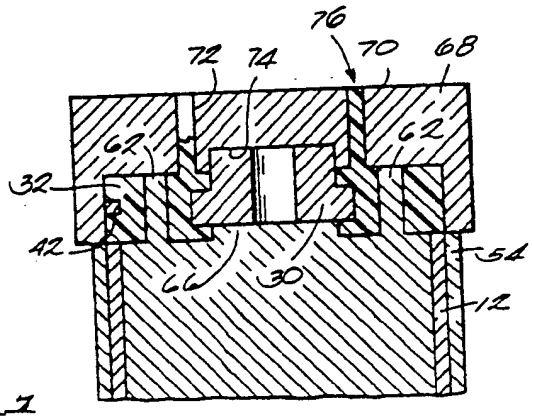

Fig. 7

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INTERNATIONAL SEARCH REPORT

International Application No PCT/US87/01062

I. CLASSIFICATION OF SUBJECT MATTER (if several classification symbols apply, indicate all) [3]

According to International Patent Classification (IPC) or to both National Classification and IPC

IPC (4): H02K 15/00
U.S. CL.: 310/89; 29/596; 264/272.2

II. FIELDS SEARCHED

Minimum Documentation Searched [4]

Classification System	Classification Symbols
U.S.	264/272.2; 310/89, 90, 43; 29/596, 598

Documentation Searched other than Minimum Documentation to the Extent that such Documents are Included in the Fields Searched [5]

III. DOCUMENTS CONSIDERED TO BE RELEVANT [14]

Category *	Citation of Document, [16] with indication, where appropriate, of the relevant passages [17]	Relevant to Claim No. [18]
X	US, A, 3,760,209 (HULT) 18 SEPTEMBER 1973 See the entire document.	1-9
X	US, A, 4,384,226 (SATO ET AL.) 17 MAY 1983 See the entire document.	1-9
A	US, A, 3,459,982 (CARTIER) 05 AUGUST 1969 See the entire document.	1-9
A	US, A, 3,444,402 (CARTIER) 13 MAY 1969 See the entire document.	10-12
A	US, A, 3,755,889 (BUSIAN) 04 SEPTEMBER 1973 See entire document.	10-12
A	US, A, 3,742,595 (LYKES) 03 JULY 1973 See entire document.	10-12
A	US, A, 3,344,513 (BEMMANN ET AL.) 03 OCTOBER 1967 See the entire document.	10-12
A	US, A, 3,707,038 (HALLERBACK) 26 DECEMBER 1972 See the entire document.	10-12

* Special categories of cited documents: [15]

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IV. CERTIFICATION

Date of the Actual Completion of the International Search [2]	Date of Mailing of this International Search Report [3]
03 DECEMBER 1987	06 JAN 1988
International Searching Authority [1]	**Signature of Authorized Officer** [20]
ISA/US	DONOVAN DUGGAN

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(71)(72) Applicant and Inventor: HENCK, Ronald, W. [US/US]; S16 W32069 Highmeadows, Delafield, WI 53018 (US).

(74) Agent: BARRY, Ronald, E.; Frisch, Dudek and Slattery, Ltd., 825 North Jefferson Street, Milwaukee, WI 53202 (US).

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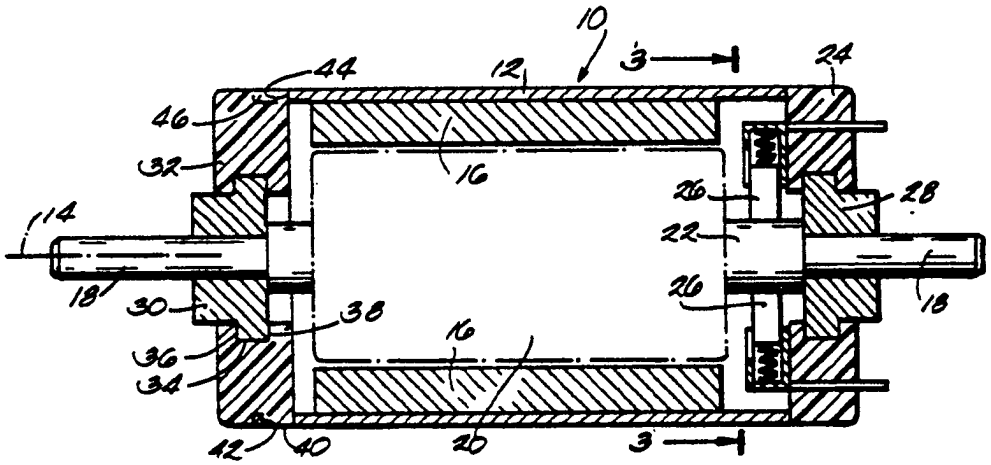

(57) Abstract

An electric motor comprising a generally cylindrical housing (12) including an end and a longitudinal axis (14) a rotor assembly located inside the housing and including a shaft (18) extending along the longitudinal axis and an armature assembly (20) mounted on the shaft, a bearing (30) rotatably supporting the shaft, and a unitary, plastic end bell (32) closing the end of the housing and being molded around the bearing.

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ELECTRIC MOTOR AND METHOD FOR MANUFACTURING THE SAME

Background of the Invention

The invention relates to electric motors and to methods for manufaturing electric motors. More particularly, the invention relates to end bells or caps for electric motors and to methods for forming the end bell or cap of an electric motor.

U.S. MacMillan Patent No. 4,357,552 discloses an end bell "molded about" a portion of the motor casing. The outer surface of the end bell has therein a cylindrical recess or pocket which receives and supports a bearing which in turn supports the output shaft of the motor.

U.S. Hult Patent No. 3,760,209 discloses a motor including a two-piece end bell which "captures" and supports a bearing for the output shaft.

Attention is also directed to the following U.S. patents which disclose electric motors:

Frey	4,088,910	May 9, 1978
Lindgren	3,161,794	Dec. 15, 1964
Singh et al.	4,031,610	June 28, 1977
de Jong	4,414,481	Nov. 8, 1983
Kaufman, Jr.	4,048,530	Sept. 13, 1977
Hahndorf et al.	3,391,290	July 2, 1968
Spitler et al.	4,384,224	May 17, 1983
Shiseki et al.	4,438,358	Mar. 20, 1984

Summary of the Invention

The invention provides an electric motor comprising a generally cylindrical housing including

an end, and a rotor assembly located inside the housing and including a shaft extending outwardly through the end of the housing. The rotor assembly also includes an armature assembly mounted on the shaft.

The motor further comprises a bearing for rotatably supporting the shaft, and a unitary (i.e., one-piece), plastic end bell which is molded around the bearing and which is molded in place on the end of the housing to close the end of the housing. Preferably, the bearing includes an annular flange extending outwardly and generally perpendicularly to the shaft, the flange having opposite inner and outer surfaces spaced in the direction of the axis of the shaft, and the bearing is captured by or molded within the end bell so that the end bell contacts both of the inner and outer surfaces of the bearing flange to hold the bearing in place relative to the housing.

In the preferred embodiment, the housing has therein a plurality of apertures spaced from the end of the housing. When the end bell is molded in place relative to the housing, the end bell forms a plurality of projections respectively received in the apertures for securing the end bell to the housing.

The invention also provides a method for manufacturing the above-described motor. The method comprises the steps of providing the housing and the

bearing, and providing a mold form defining a molding chamber for the end bell. In the preferred embodiment, the mold form includes an annular recess which receives the housing, and the mold form forms the molding chamber around the end of the housing. More particularly, the mold form includes a base which receives the housing and which defines the bottom of the molding chamber, and a top which is mounted on the base over the end of the housing and which defines the sides and top of the molding chamber. The base includes an upwardly extending projection which supports the bearing within the molding chamber, and the top includes a generally cylindrical recess which receives the upper or outer end of the bearing for positioning the bearing relative to the end of the housing.

The method further comprises the steps of locating the housing in the mold form with the end of the housing in the molding chamber, and placing the bearing inside the molding chamber on the projection. As mentioned above, the recess in the top of the mold form holds the bearing in proper position.

The method further comprises the step of delivering molten plastic into the mold chamber. The plastic surrounds the bearing and becomes molded to the housing so that, when the plastic hardens, the plastic forms the end bell.

A principal feature of the invention is the provision of a unitary or one-piece end bell molded around a bearing. This construction is simpler than known constructions and provides more effective support of the bearing.

Another principal feature of the invention is the method for making the motor. The method is simple and yet provides the above-described improved end bell.

Other principal features and advantages of the invention will become apparent to those skilled in the art upon review of the following detailed description, claims and drawings.

Description of the Drawings

Fig. 1 is a perspective view of an electric motor embodying the invention.

Fig. 2 is a cross-sectional view of the motor.

Fig. 3 is a cross-sectional view taken along line 3-3 in Fig. 2.

Fig. 4 is an end view (the left end in Figs. 1 and 2) of the motor.

Fig. 5 is a vertical cross-sectional view of a mold form used in performing the method of the invention.

Fig. 6 is a top view of the base of the mold form.

Fig. 7 is a partial view of the upper portion of the mold form shown in Fig. 5 with molten plastic filling the molding chamber.

Before one embodiment of the invention is explained in detail, it is to be understood that the invention is not limited in its application to the details of construction and the arrangements of components set forth in the following description or illustrated in the drawings. The invention is capable of other embodiments and of being practiced or being carried out in various ways. Also, it is to be understood that the phraseology and terminology used herein is for the purpose of description and should not be regarded as limiting.

Description of the Preferred Embodiment

An electric motor 10 embodying the invention is shown in the drawings. As best shown in Fig. 2, the motor 10 comprises a generally cylindrical housing 12 including opposite right and left ends and a longitudinal axis 14. The motor 10 also comprises a pair of stator elements 16 mounted inside the housing 12, and a rotor assembly located inside the housing 12 and inside the stator elements 16. The rotor assembly includes a shaft 18 extending along the longitudinal axis 14 of the housing 12, an armature assembly 20 mounted on the shaft 18, and a commutator 22 connected to the armature assembly 20.

The motor 10 also comprises a pair of brushes 26 which contact the commutator 22 and which are adapted to be connected to a power source.

The motor 10 further comprises a bearing 28 rotatably supporting the right end of the shaft 18, and a bearing 30 rotatably supporting the left end of the shaft 18.

The motor 10 further comprises a unitary (i.e., one-piece), plastic end bell 32 closing the left end of the housing 12 and being molded around the bearing 30. The bearing 30 and the end bell 32 include interengaging means for preventing movement of the bearing 30 relative to the end bell 32 in both directions along the longitudinal axis 14 of the housing. While various suitable interengaging means can be employed, in the illustrated construction, the bearing 30 includes an annular flange 34 extending radially outwardly and generally perpendicularly to the longitudinal axis 14. The flange 34 has opposite outer and inner or left and right surfaces 36 and 38, respectively, spaced in the direction of the longitudinal axis 14, and the end bell 32 is molded around the bearing 30 so as to contact both of the left and right surfaces 36 and 38, thereby preventing movement of the bearing 30 in the direction of the longitudinal axis 14. The end bell 32 also contacts the radially outer surfaces of the bearing 30 to

prevent movement of the bearing 30 radially of the longitudinal axis 14.

The motor 10 further comprises interengaging means on the housing 12 and on the end bell 32 for securing the end bell 32 to the housing 12. While various suitable interengaging means can be used, in the preferred embodiment, the interengaging means includes, in the housing 12, a plurality of recesses 42 adjacent the end of the housing, and, on the end bell 32, a plurality of integral projections 40 respectively received in the recesses 42. In the illustrated construction, the housing 12 includes a plurality of apertures spaced from the end of the housing 12 and defining the recesses 42. Furthermore, in the preferred embodiment, the interengaging means includes, in the left end of the housing 12, a plurality of longitudinally extending recesses 44, and, on the end bell 32, a plurality of integral projections 46 respectively received in the longitudinally extending recesses 44. Both the apertures 42 and the longitudinally extending recesses 44 prevent rotation of the end bell 32 relative to the housing 12, and the apertures 42 further prevent movement of the end bell relative to the housing in the direction of the longitudinal axis 14.

As shown in Fig. 4, the end bell 32 has therein a pair of generally cylindrical openings 48

for facilitating mounting of the motor 10, and a pair of arcuate vent openings 50.

The motor 10 further comprises (See Figs. 2 and 3) an end bell 24 closing the right end of the housing 12 and supporting the brushes 26 and the bearing 28. While the end bell 24 can be of conventional construction, in the illustrated construction, the end bell 24 at least partially embodies the invention in that it is unitary and captures the bearing 28. The end bell 24 can be secured to the right end of the housing 12 by any suitable means.

A mold form 52 for performing the method of the invention, i.e., a method for manufacturing the motor 10, is illustrated in Figs. 5 through 7.

As best shown in Fig. 5, the mold 52 form includes a base 54 which defines an annular recess 56 for receiving the housing 12. The right end of the housing 12 is inserted into the recess 56 in the base 54, and the left end of the housing 12 extends upwardly out of the base 54. The base 54 has an upper surface 58 which defines the bottom of a molding chamber 60 for forming the end bell 32. The base 54 includes a pair of generally cylindrical, upwardly extending projections 62 which form the openings 48 in the end bell 32, and a pair of arcuate, upwardly extending projections 64 which form the arcuate openings 50 in the end bell. The base 54

also includes a generally cylindrical, upwardly extending projection 66 for supporting the bearing 30 within the molding chamber 60.

The mold form 52 also includes a top 68 which is mounted on the base 54 and which defines the sides and top of the molding chamber 60. Thus, the top 68 and the base 54 cooperate to define the molding chamber 60. The top 68 contacts the projections 62 and the arcuate projections 64, and the top 68 fits over the end of the housing 12 and is thereby held in position relative to the housing 12. The top 68 can be secured to the base 54 by any suitable means.

The top 68 includes a gate 70 communicating with the molding chamber 60, and a vent 72 communicating with the molding chamber 60. Preferably, the top 68 also includes means for positioning the bearing 30 relative to the end of the housing 12. While various suitable positioning means can be used, in the illustrated construction, the positioning means includes a generally cylindrical recess 74 in the top 68 of the mold form 52. The recess 74 receives the top or outer portion of the bearing 30 and thereby positions the bearing within the molding chamber 60 and relative to the end of the housing 12.

The method of the invention is performed as follows: The housing 12 is inserted into the annular

recess 56 in the base 54, as shown in Fig. 5, and the bearing 30 is placed on the projection 66. The top 68 is then placed over the end of the housing 12 and on the base 54 with the outer portion of the bearing 30 received in the recess 74. When the top 68 is placed on the base 54, the top 68 and base 54 define the molding chamber 60, the end of the housing 12 is located within the molding chamber 60, and the bearing 30 is located within the molding chamber 60 in proper position relative to the end of the housing 12. Finally, molten plastic 76 is delivered into the molding chamber 60 via the gate 70. As shown in Fig. 7, the molten plastic 76 surrounds the bearing 30 and fills the apertures 42 and the longitudinally extending recesses 44. When the plastic hardens, it forms the end bell 32 closing the end of the housing 12 and surrounding or capturing the bearing 30.

In accordance with this invention an end bell closure is provided for the motor housing 12 which is molded in place and secured to the motor housing 12 through a molded interengagement between the end bell and the housing 12 without the need for any separate screws or the like or the need for additional assembly steps such as deforming the housing end to engage the end bell, while at the same time the bearing 30 is molded in place in the end bell. The location of the bearing axis is thereby accurately controlled for true mounting of the motor

armature. This has a positive effect on improving motor performance and extending motor life. For example, by maintaining a concentric relationship between the armature and the stator magnets 16, a stronger and more efficient magnetic field is produced. The preferred interengagement is shown as molded projections 40 in apertures or recesses 42. This holds the end bell assembled on the housing 12. The engagement between the projections 46 and recesses 44 resists any torque which may be applied to the end bell in operation, thereby allowing this concept to be used with larger size motors, if desired.

Various other features and advantages of the invention are set forth in the following claims.

CLAIMS

1. An electric motor comprising

a generally cylindrical housing including an end and a longitudinal axis,

a rotor assembly located inside said housing and including a shaft extending along said longitudinal axis and an armature assembly mounted on said shaft,

a bearing rotatably supporting said shaft,

a unitary, plastic end bell closing said end of said housing and being molded around said bearing, and

interengaging means on said housing and on said end bell for securing said end bell to said housing.

2. A motor as set forth in Claim 1 wherein said interengaging means includes, in said housing, a plurality of recesses adjacent said end of said housing, and, on said end bell and integral therewith, a plurality of projections respectively received in said recesses.

3. A motor as set forth in Claim 2 wherein said housing includes a plurality of apertures spaced from said end of said housing and defining said recesses.

4. A motor as set forth in Claim 2 wherein said interengaging means further includes, in said end of said housing, a plurality of longitudinally extending recesses, and, on said end bell and integral therewith, a plurality of projections respectively received in said longitudinally extending recesses.

5. A motor as set forth in Claim 1 wherein said bearing includes an annular flange extending radially outwardly and generally perpendicularly to said longitudinal axis, said flange having opposite inner and outer surfaces spaced in the direction of said longitudinal axis, and wherein said end bell is molded around said bearing so as to contact both of said inner and outer surfaces, thereby preventing movement of said bearing in the direction of said longitudinal axis.

6. A motor as set forth in Claim 1 wherein said bearing and said end bell include interengaging means for preventing movement of said bearing relative to said end bell in both directions along said longitudinal axis.

7. An electric motor comprising

a generally cylindrical housing including an end, a longitudinal axis, and a plurality of apertures adjacent said end of said housing,

a rotor assembly located inside said housing and including a shaft extending along said longitudinal axis and an armature assembly mounted on said shaft,

a bearing rotatably supporting said shaft and including an annular flange extending radially outwardly and generally perpendicularly to said longitudinal axis, said flange having opposite inner and outer surfaces spaced in the direction of said longitudinal axis, and

a unitary, plastic end bell closing said end of said housing and being molded around said bearing so as to contact both of said inner and outer surfaces, thereby preventing movement of said bearing in the direction of said longitudinal axis, said end bell including a plurality of integral projections respectively received in said apertures.

8. In an electric motor including an armature, a housing enclosing said armature, and bearings rotatably supporting the opposite ends of said armature, the improvement comprising an end bell molded around one of said bearings and having an interengagement with said one of said bearings such that said bearing is held captive in said end bell.

9. The electric motor of claim 8 wherein said end bell is further characterized in that it includes integral projections molded in engagement with said housing adjacent the end of said housing to prevent axial and rotational movement of said end bell, and the bearing held captive thereby, relative to said armature.

10. A method for manufacturing an electric motor, said method comprising the steps of

providing a generally cylindrical housing including an end,

providing a bearing for rotatably supporting a shaft,

providing means defining a molding chamber,

locating said end of said housing within said molding chamber,

locating said bearing within said molding chamber in proper position relative to said end of said housing, and

delivering molten plastic into said chamber,

whereby said molten plastic surrounds said bearing and becomes molded to said housing so that, when said plastic hardens, said plastic forms an end bell closing said end of said housing and surrounding said bearing.

11. A method as set forth in Claim 10 wherein said means defining said chamber includes means for positioning said bearing relative to said end of said housing.

12. A method as set forth in Claim 10 wherein said housing includes a plurality of recesses spaced from said end, whereby said molten plastic fills said recesses to provide means for securing said end bell to said housing.

AMENDED CLAIMS

[received by the International Bureau on 12 October 1987 (12.10.87)
original claims 1-12 replaced by amended claims 1-12 (3 pages)]

1. An electric motor comprising

a generally cylindrical housing including an end and a longitudinal axis, interengaging means at said end of said housing,

a rotor assembly located inside said housing and including a shaft extending along said longitudinal axis and an armature assembly mounted on said shaft,

a bearing located at said end of said housing for rotatably supporting one end of said shaft, and

a unitary, plastic end bell closing said end of said housing and being molded around said bearing and extending into said

interengaging means on said end of said housing for positively locating said bearing in said end of said housing.

2. A motor as set forth in Claim 1 wherein said interengaging means includes, in said housing, a plurality of recesses adjacent said end of said housing, and, on said end bell and integral therewith, a plurality of projections respectively received in said recesses.

3. A motor as set forth in Claim 2 wherein said housing includes a plurality of aperatures spaced from said end of said housing and defining said recesses.

4. A motor as set forth in Claim 2 wherein said interengaging means further includes, in said end of said housing, a plurality of longitudinally extending recesses, and, on said end bell and integral therewith, a plurality of projections respectively received in said longitudinally extending recesses..

5. A motor as set forthin Claim 1 wherein said bearing includes an annular flange extending radially outwardly and generally perpendicularly to said longitudinal axis, said flange having opposite inner and outer surfaces spaced in the direction of said longitudinal axis, and wherein said end bell is molded around said bearing so as to contact both of said inner and outer surfaces, thereby preventing movement of said bearing in the direction of said longitudinal axis.

6. A motor as set forth in Claim 1 wherein said bearing and said end bell include interengaging means for preventing movement of said bearing relative to said end bell in both directions along said longitudinal axis.

7. An electric motor comprising

a generally cylindrical housing including an end, a longitudinal axis, and a plurality of apertures adjacent said end of said housing,

a rotor assembly located inside said housing and including a shaft extending along said longitudinal axis and an armature assembly mounted on said shaft,

a bearing rotatably supporting said shaft and incuding an annular flange extending radially outwardly and generally perpendicularly to said longitudinal axis, said flange having opposite inner and outer surfaces spaced in the direction of said longitudinal axis, and

a unitary, plastic end bell closing said end of said housing and being molded around said bearing so as to contact both of said inner and outer surfaces and including a plurality of integral projections received in said aperatures, thereby preventing movement of said bearing with respect to said end of said housing.

8. In an electric motor including an armature, a housing enclosing said armature and having a plurality of openings around one end of said housing, and bearings rotatably supporting the opposite ends of said armature, the improvement comprising an end bell molded around one of said bearings and having an interengagment with said one of said bearings and said openings in said one end of said housing, such that said bearing is fixed with respect to said one end of said housing and said end bell.

9. The electric motor of claim 8 wherein said end bell is further characterized in that it includes integral projections molded in engagement with said openings in said housing adjacent said end of said housing to prevent axial and rotational movement of said end bell, and the bearing held captive thereby, relative to said armature.

10. A method for manufacturing an electric motor, said method comprising the steps of

providing a generally cylindrical housing including an end,

providing a bearing for rotatably supporting a shaft,

providing means defining a molding chamber,

locating said end of said housing within said molding chamber,

locating said bearing within said molding chamber in proper position relative to said end of said housing, and

delivering molten plastic into said chamber,

whereby said molten plastic surrounds said bearing and becmes molded to said housing so that, when said plastic hardens, said plastic forms an end bell closing said end of said housing and surrounding said bearing.

11. A method as set forth in Claim 10 wherein said means defining said chamber includes means for positioning said bearing relative to said end of said housing.

12. A method as set forth in Claim 10 wherein said housing includes a plurality of recesses spaced from said end, whereby said molten plastic fills said recesses to provide means for securing said end bell to said housing.

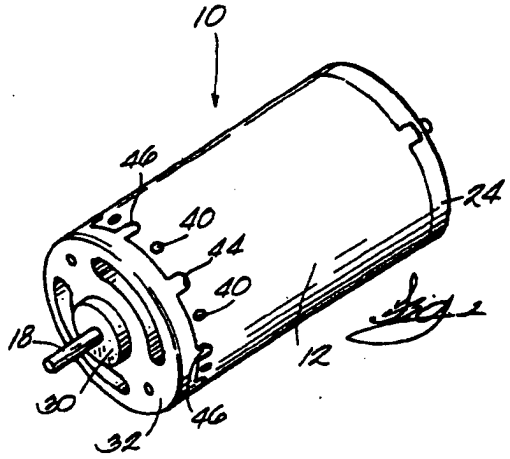


Fig. 1

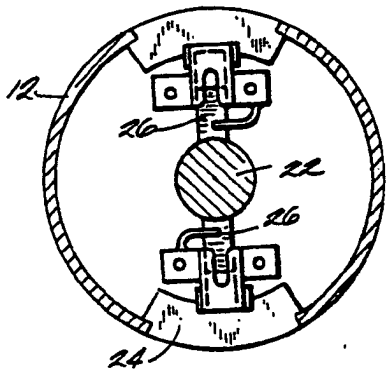
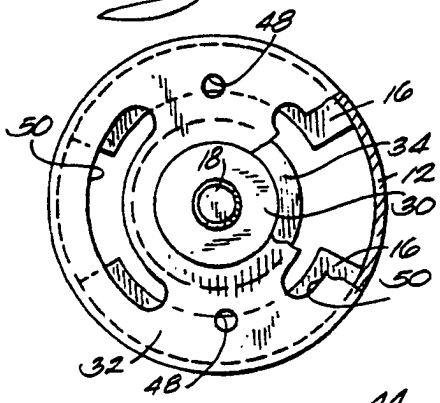


Fig. 3

Fig. 4



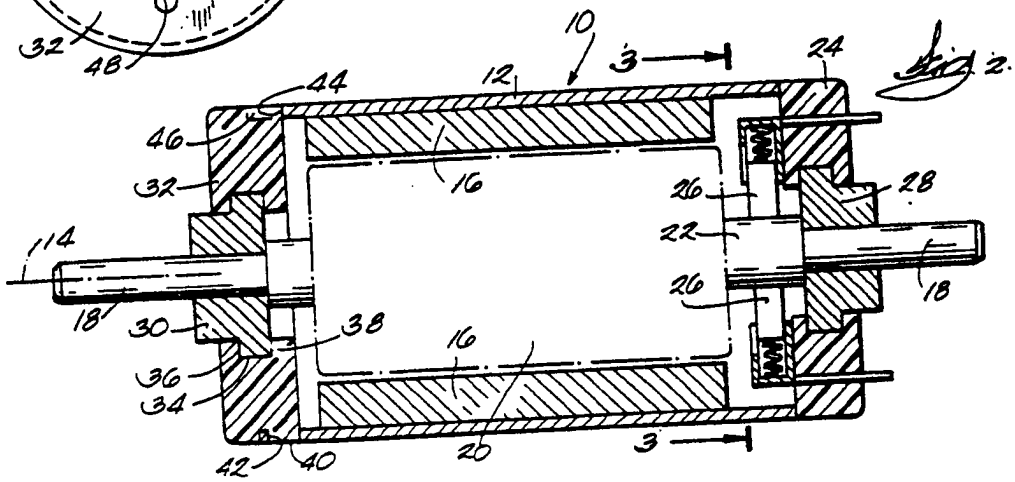


Fig. 2

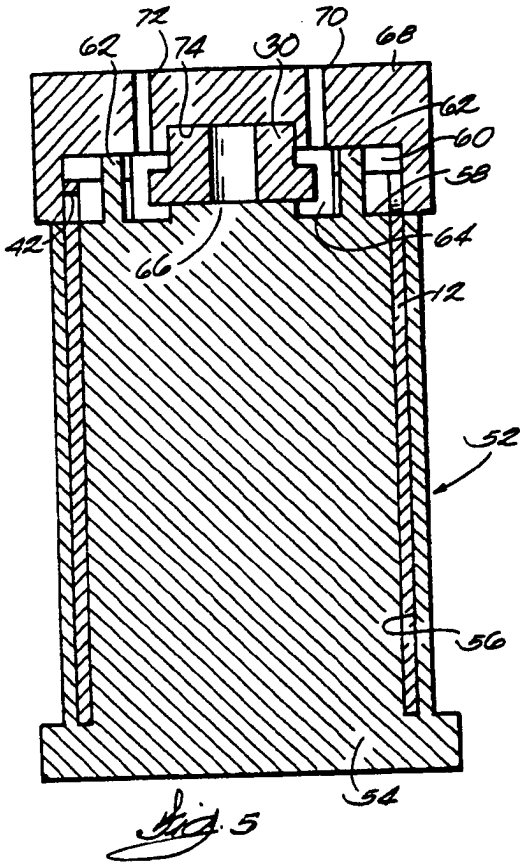


Fig. 5

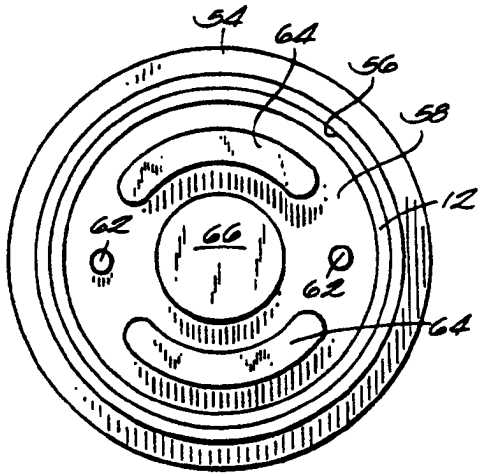


Fig. 6

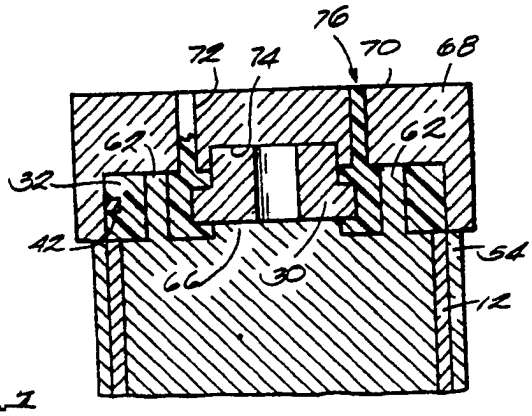


Fig. 7

INTERNATIONAL SEARCH REPORT

International Application No PCT/US87/01062

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IPC (4): H02K 5/00; H02K 15/00

U.S. CL. 310/89; 29/596

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IV. CERTIFICATION

Date of the Actual Completion of the International Search [2]	Date of Mailing of this International Search Report [3]
17 July 1987	29 JUL 1987
International Searching Authority [1]	**Signature of Authorized Officer [20]**
ISA/US	Donovan F. Duggan

Form PCT/ISA/210 (second sheet) (May 1986)

FURTHER INFORMATION CONTINUED FROM THE SECOND SHEET

V. ☐ OBSERVATIONS WHERE CERTAIN CLAIMS WERE FOUND UNSEARCHABLE [10]

This international search report has not been established in respect of certain claims under Article 17(2) (a) for the following reasons:

1. ☐ Claim numbers . . , because they relate to subject matter [12] not required to be searched by this Authority, namely:

2. ☐ Claim numbers ..... , because they relate to parts of the international application that do not comply with the prescribed requirements to such an extent that no meaningful international search can be carried out [13], specifically:

VI. ☒ OBSERVATIONS WHERE UNITY OF INVENTION IS LACKING [11]

This International Searching Authority found multiple inventions in this international application as follows:

I. Claims 1-9 drawn to an electric motor; class 310 subclass 89.

II. Claims 10-12 drawn to a method of making an electric motor; class 29 subclass 596.

1. ☐ As all required additional search fees were timely paid by the applicant, this international search report covers all searchable claims of the international application.

2. ☐ As only some of the required additional search fees were timely paid by the applicant, this international search report covers only those claims of the international application for which fees were paid, specifically claims:

3. ☒ No required additional search fees were timely paid by the applicant. Consequently, this international search report is restricted to the invention first mentioned in the claims; it is covered by claim numbers:

1-9

4. ☐ As all searchable claims could be searched without effort justifying an additional fee, the International Searching Authority did not invite payment of any additional fee.

Remark on Protest

☐ The additional search fees were accompanied by applicant's protest.

☐ No protest accompanied the payment of additional search fees.